Paleontological Research, vol. 2, no. 3, pp. 170-182, 7 Figs., September 30, 1998

Two ammonite species of *Mortoniceras* from the Yubari Mountains (Hokkaido) and their geological implications

(Studies of the Cretaceous ammonites from Hokkaido and Sakhalin-LXXXII)

TATSURO MATSUMOTO[1], FUMIHISA KAWABE[2] and YOSHITARO KAWASHITA[3]

[1]c/o *Kyushu University 33, Fukuoka 812-8581, Japan*

[2]*Division of Geology, Graduate School of Science and Engineering, Waseda University, Tokyo 169-8050, Japan*

[3]*2-179, Tomatsu Chiyoda, Mikasa 068-2134, Japan*

Received 11 February 1998 ; Revised manuscript accepted 23 July 1998

Abstract. **Two ammonite species of the genus *Mortoniceras* have been recently obtained from two stratigraphic units, Member Ld of the Lower Yezo Subgroup and Member Mb of the Middle Yezo Subgroup on the Tengu-zawa route of the Yubari Mountains, central Hokkaido. They are identified respectively with *Mortoniceras* (*Mortoniceras*) cf. *geometricum* Spath and *Mortoniceras* (*Mortoniceras*) *rostratum* (J. Sowerby). *M.* (*M.*) *geometricum*, which is taken here as allied to *M.* (*M.*) *pricei* (Spath), probably includes some specimens described as *Pervinguieria arietiformis* by Haas (1942b) from Angola and as *M.* (*M.*) *arietiforme* by Renz (1971) from Venezuela. Our study of *Mortoniceras* (*Mortoniceras*) *rostratum* suggests that *Ammonites rostratus* J. Sowerby should be systematically assigned to *Mortoniceras* (*Mortoniceras*) rather than to *M.* (*Subschloenbachia*). On the evidence of the two ammonite species, Member Ld is correlated with the middle part (probably the *Hysteroceras varicosum* Subzone) of the Upper Albian and Member Mb with the upper part (probably the *M.* (*M.*) *rostratum* Subzone) of the same substage. Therefore, no significant time gap exists at the boundary of the Lower and Middle Yezo Subgroups.**

Key words : Correlation, *Mortoniceras* (*Mortoniceras*) *geometricum*, *Mortoniceras* (*Mortoniceras*) *rostratum*, Upper Albian, Yezo Group, Yubari Mountains

Introduction

The Albian part of the Cretaceous Yezo Group in the forearc basin of Hokkaido and Sakhalin is not so prolific in ammonoids as the same stage in the well studied regions of western Europe. In Europe and adjacent regions of the Boreal Province, the hoplitid ammonites occur abundantly and are very useful for biostratigraphic zonation and correlation (Owen, 1979). For palaeobiogeographic reasons they are almost absent in Japan and adjacent areas. There the acanthocerataceans, including Brancoceratidae (or Mojsisovicziidae by some authors), are found from time to time and helpful for the interregional correlation, for they include worldwide species.

In this paper we report the find of two Albian species of *Mortoniceras* in our recent field work. They are interesting in the systematics of the genus and also useful for a particular stratigraphic problem.

The repositories of the described specimens are abbreviated as follows :

GK : Type Room, Department of Earth and Planetary Sciences, Kyushu University, Fukuoka 812-8581, Japan

GS : Institute of Earth Science, Saga Univertity, Saga 840-8502, Japan

WE : Institute of Earth Science, School of Education, Waseda University, Tokyo 169-8050, Japan

Stratigraphic setting

The specimens described in this paper were obtained from the Cretaceous Yezo Group of the Yubari Mountains in central Hokkaido (see index map in Figure 1).

The Cretaceous stratigraphy in the Yubari Mountains has been investigated by a number of geologists. The paper by Matsumoto (1942) is one of the results and partly cited in this paper. We depend, however, mainly on the recent work by Kawabe *et al.* (1996). Hence, we omit to describe repeatedly the details of the stratigraphy. The important points to be noted for the subject of this paper are as follows :

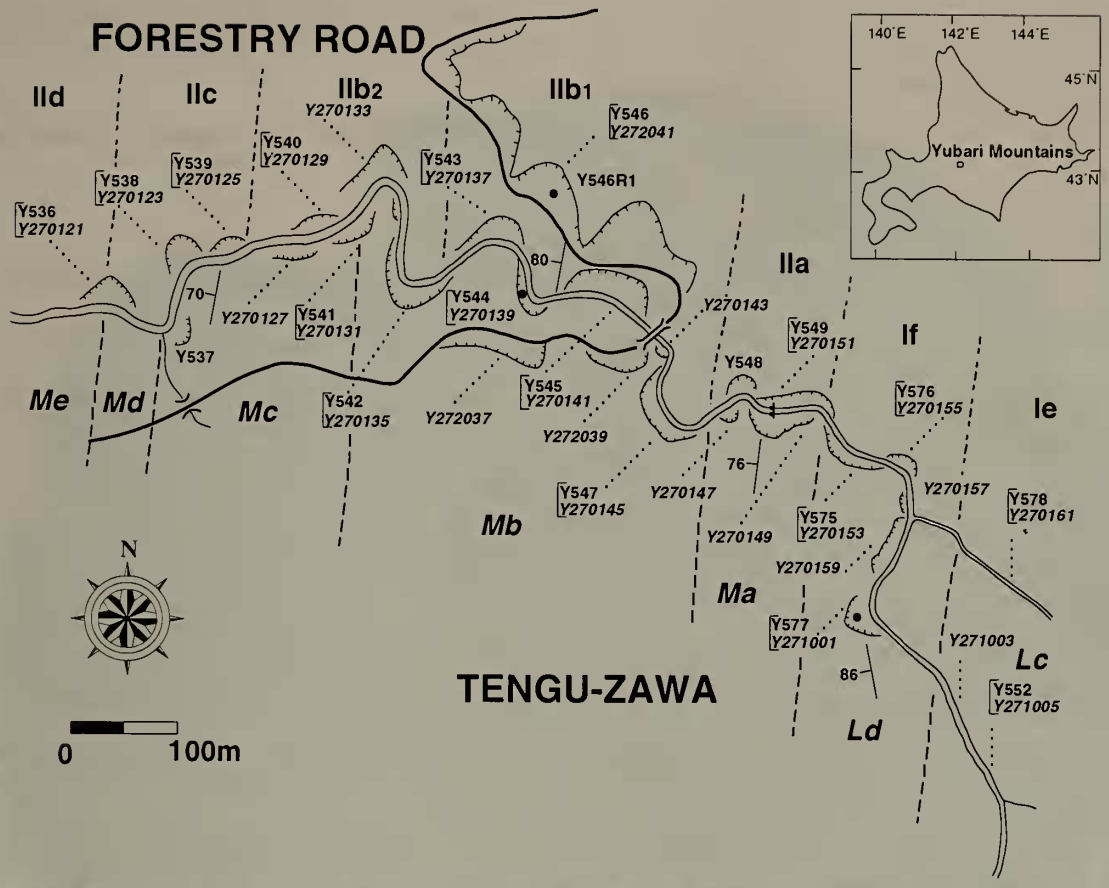

Figure 1. Geological route map along the Tengu-zawa (part) of the Yubari Mountains. Stratigraphic divisions and the number of outcrops by Matsumoto (1942 : above) and Kawabe *et al.* (1996 : below) are shown.

(1) The ammonites described below were obtained from the two units in the continuous outcrops along the upper course of the Tengu-zawa [=Tengu-sawa by some authors], a branch stream of the River Shuparo [=Shuyubari or Siyubari by some authors]. For the general geological map of the Shuparo Valley readers may refer to Kawabe *et al.* (1996, fig. 2) and the columnar sections of the Cretaceous deposits along the selected six routes (including the Tengu-zawa route) are shown in fig. 3 of the same paper.

(2) In this paper we follow Matsumoto (1995, p. 6) and Nishida *et al.* (1996, p. 67, 93) and use the Subgroup category for each of the major lithostratigraphic divisions of the thick deposits of the Yezo Group. Local formational names are omitted for brevity. Members are designated by letters.

(3) Details of the relevant part of the Tengu-zawa route are shown in Figure 1, in which the stratigraphic subdivisions (i.e., Members) and the outcrop numbers of Matsumoto (1942) [above] and also Kawabe *et al.* (1996) [below] are both shown. As to the stratigraphic subdivisions there is discrepancy, though partially, between the two schemes. We now agree to regard the scheme of Kawabe *et al.* (1996) as more reasonable and natural than that of Matsumoto (1942).

(4) The main lithologic constituents and thickness of the successive members are shown in the columnar sections of Figure 2. The locality numbers and horizons of the two ammonite species are also indicated in the same figure.

(5) The ammonite from the Member Ld was embedded directly in the dark grey mudstone, without forming a nodule.

(6) The ammonites from the dark grey mudstones of the Member Mb were in calcareous nodules. In addition to the described species, *Anagaudryceras sacya* (Forbes), undetermined heteromorph ammonoids and a new kind of inoceramid bivalve have been obtained from the same outcrops. Plant drifts, including fragmentary pieces of wood, are frequently embedded.

(7) Aside from the ammonites from the Members Ld and Mb, the mudstones of the Member Me have yielded more ammonoids, such as *Desmoceras* (*Desmoceras*) *kossmati* Matsumoto, *Desmoceras* (*Pseudouhligella*) *japonicum* Yabe etc. *Graysonites wooldridgei* Young and *Parajaubertella kawakitana* Matsumoto, among others, indicate that the lower part of the Member Me [=IId] is referable to the lower Cenomanian.

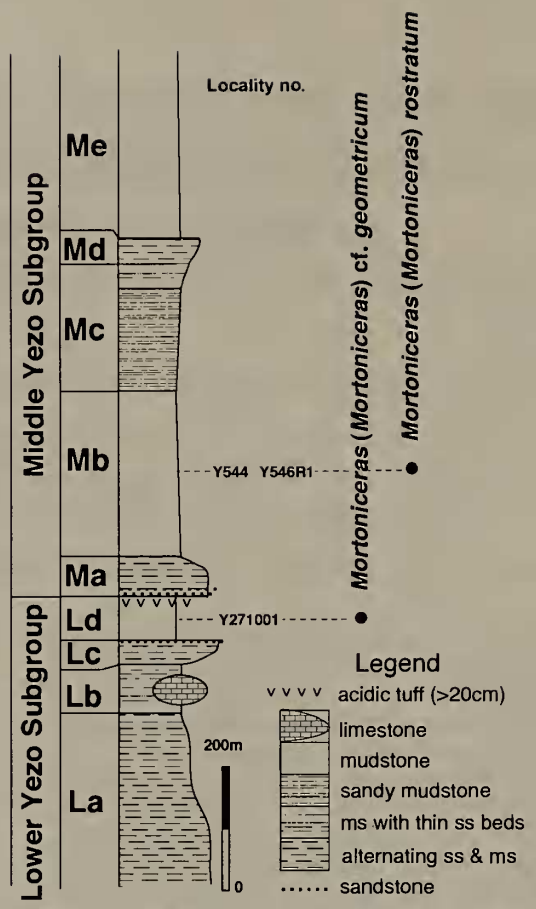

Figure 2. Schematic columnar section along the Tengu-zawa route (part) of the Yubari Mountains.

Palaeontological descriptions

Superfamily Acanthocerataceae Grossouvre, 1894
Family Brancoceratidae Spath, 1900
Subfamily Mortoniceratinae H. Douvillé, 1912
Genus ***Mortoniceras*** Meek, 1876

Type species.—*Ammonites vespertinus* Morton, 1834, by original designation of Meek (1876, p. 448).

Subgenus ***Mortoniceras (Mortoniceras)*** Meek, 1876

Remarks.—Subfamily Mortoniceratinae is allocated in the family Mojsisovicziidae Hyatt by Kennedy (*in* Gale *et al.*, 1996, p. 557), but we follow Wright (1996, p. 134–140) in placing the subfamilies Brancoceratinae, Mojsisovicziinae and Mortoniceratinae in the family Brancoceratidae Spath.

Ammonites vespertinus Morton, 1834 was disregarded by several authors as invalid, but Morton's original specimen (holotype) and other specimens subsequently collected show the diagnostic character, as one of us has described briefly (Matsumoto, 1960, p. 37, fig. 1). As to the definition of the genus *Mortoniceras* we agree with Wright (1996, p. 141). Classification of the subgenus *Mortoniceras* seems to be somewhat confusing, but we follow Wright (1996) for the time being.

Mortoniceras (Mortoniceras) cf. ***geometricum*** Spath, 1932

Figure 3

Compared.—
Mortoniceras (*Pervinquieria*) *geometricum* Spath, 1932, p. 395; Spath, 1933, pl. 44, fig. 1.
Pervinquieria arietiformis (Spath). Haas, 1942b, pl. 19, fig. 2; pl. 20, fig. 4.
Mortoniceras (*Mortoniceras*) *arietiforme* (Spath). Renz, 1971, p. 598, pl. 4, fig. 1, text-fig. 5b; Renz, 1982, p. 53, pl. 13, figs. 1a, 1b.
non. Elobiceras arietiforme Spath, 1922, p. 137, pl. 2, figs. 6a, 6b.

Material.—WE.A211Y, obtained by F.K. on 10 September 1993 at loc. Y271001 [=Y577], from the Member Ld along the Tengu-zawa route, Yubari Mountains.

Description.—The specimen is a secondarily distorted and compressed internal mould (Figure 3). It was embedded directly in mudstone without forming a nodule.

The shell is fairly large and loosely coiled. The whorl expands with a low ratio, enlarging rather slowly. Consequently the umbilicus is very wide. The whorl is fairly higher than broad, but the original proportion of B/H cannot be accurately measured.

The keel is moderately high on the inner whorl. On the outer whorl the keel is broken or unpreserved for the most part, but it seems to have been fairly high as can be inferred from its broken base. It may increase its height with growth.

The ornament is characteristic. On the outer whorl, that consists of the adult body chamber and the last part of the phragmocone, ribs are mostly long, single and uniformly disposed. Only a few are slightly shorter, without reaching the umbilical edge. They are mostly rectiradiate and a few ribs on the last portion tend to curve gently forward. This might suggest the presence of a rostrum, which itself is regrettably unpreserved. On the body chamber every rib is swollen at the ventrolateral shoulder and bent there more or less forward. The long rib has a blunt bulla at the umbilical edge. A mid-lateral tubercle is almost imperceptible on the body chamber.

In the preceding stage for a little more than one full whorl, the ribs are alternatingly long and short or sometimes bifurcated (Figure 3). Most of the ribs are roughly rectiradiate, but a few of them are slightly flexiradiate. At this stage the bullate umbilical tubercles at the end of the long rids are often more distinct than those of the last growth stage. The inner ventrolateral tubercles are likewise more distinct than those of the late stage. Namely, they form distinct tubercles. At least some of these inner ventrolateral tubercles are accompanied by feeble outer ventrolateral clavi. Also at this growth stage lateral tubercles are weakly developed on some ribs.

The ornament of the still earlier part (less than 40 mm in diameter) is not well shown.

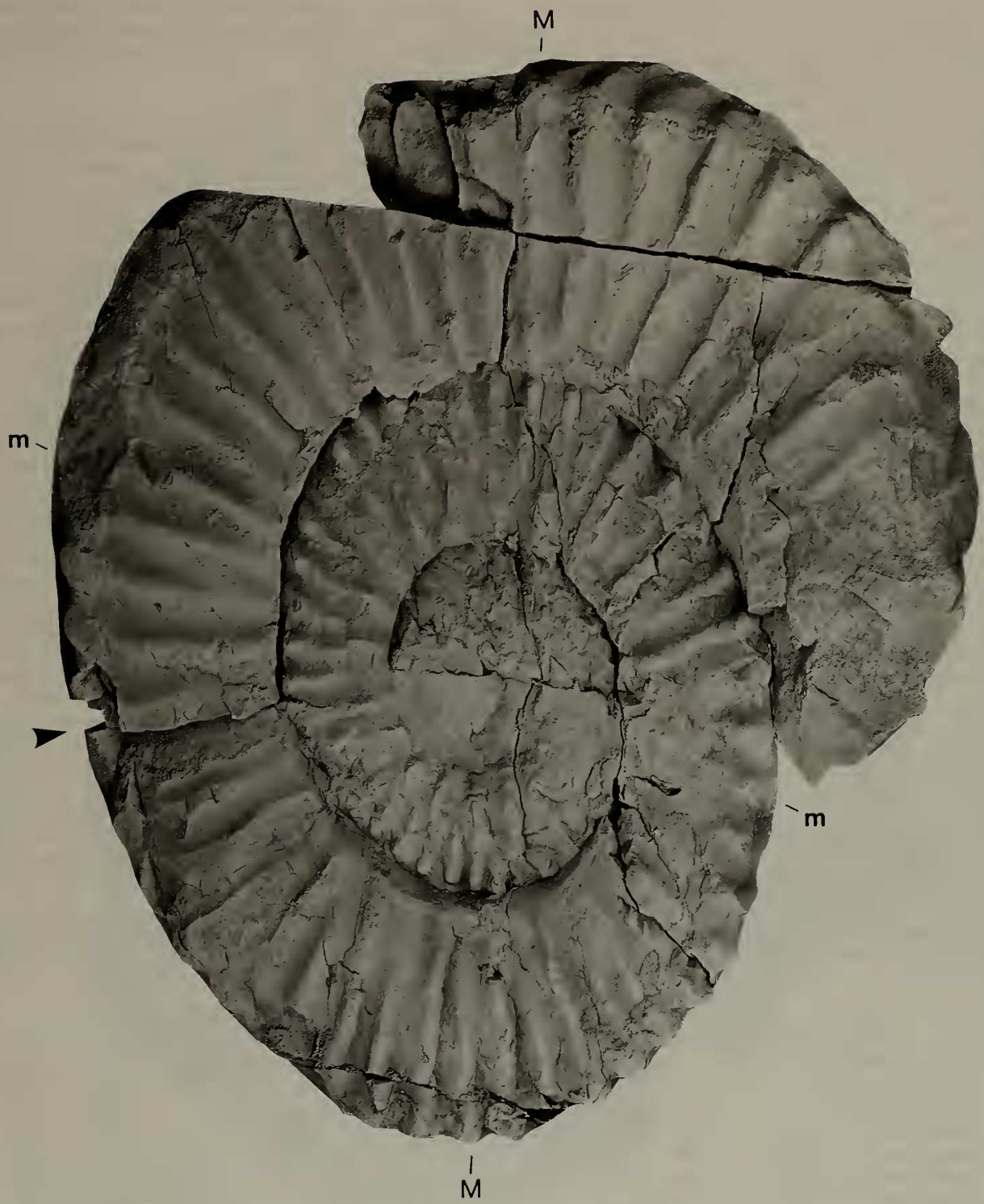

Figure 3. *Mortoniceras* (*Mortoniceras*) cf. *geometricum* (Spath). Lateral view of WE. A211Y from Member Ld at loc. Y271001, ×1 (photo by F.K. with whitening). M, m: measured points (see Table 1); arrow: last septum.

As this specimen is an internal mould, the spiral notches are hardly discernible. However, some of them are faintly impressed on several ribs on the outer half of the flank at about the beginning of the body chamber (see Figure 3).

The suture is partly exposed, but it cannot be fully traced. The last septum seems to be located at about the damaged point that is indicated by an arrow mark in Figure 3. The body chamber is hence at least half a whorl.

Dimensions.—See Table 1.

Comparison.—The specimen was indicated, without description, as *Mortoniceras* (*Mortoniceras*) cf. *inflatum* (Sowerby) by Kawabe *et al.* (1996, p. 448, pl. 2, fig. 6). That tentative identification should be revised. *Mortoniceras* (*Mortoniceras*) *inflatum* in a correct sense (see Spath, 1931, pl. 35, fig. 9; 1932, p. 384, pl. 37, fig. 1; pl. 39, fig. 2; pl. 42, fig. 6; text-figs. 125-129, 130a, 130b; 1933, pl. 43, fig. 1) has a distinct median row of tubercles on the flank in early to middle growth stages and the umbilical tubercles are strong, whereas in our specimen such distinct flank tubercles are not developed and the ribs are bullate and blunt at the umbilical end. In *Mortoniceras* (*Mortoniceras*) *inflatum* the bifurcated or alternated ribs persist to later growth stages, but in our specimen single ribs predominate on the late septate whorl to the body chamber.

In many respects the Hokkaido specimen is similar to *Mortoniceras* (*Mortoniceras*) *geometricum* Spath (1932, p. 395; 1933, pl. 44, fig. 1) from the *varicosum* Subzone (Bed 10) of the Upper Gault. The holotype of that species is somewhat, but not much, larger than the specimen from Hokkaido (see Table 1) and preserves a high keel. In our specimen the keel is destroyed for the major part of the outer whorl. However, a moderately high keel runs continuously on the inner whorl. Because the basal section of the destroyed keel is traced here and there along the abraded mid-venter of the outer whorl (Figure 3), the keel must have existed originally.

Our specimen closely resembles one of the specimens from the Upper Albian of Venezuela illustrated by Renz (1971, pl. 4, fig. 1, text-fig. 5b; also Renz, 1982, p. 53, pl. 13, figs. 1a, 1b). That specimen was described as *Mortoniceras* (*Mortoniceras*) *arietiforme* (Spath), although Renz (1968a, p. 625) himself once compared it with *Mortoniceras* (*Mortoniceras*) *geometricum*. Likewise, our specimen is quite similar to some of the specinens illustrated by Haas (1942b, pl. 19, fig. 2; pl. 20, fig. 4) under the specific name of *Pervinquieria arietiformis* (Spath).

Occurrence.—As for material.

Discussion.—*Elobiceras*, a genus of the Mortoniceratinae in our present knowledge, was established by Spath (1921, p. 306) on the basis of "*Schloenbachia elobiensis* Szajnocha, 1885" as the type species. Spath (1922, p. 137) also designated "*Schloenbachia* cf. *lenzi* Szajnocha" of Choffat (1888, p. 65, pl. 1, fig. 6) as the holotype of another species of this genus, *Elobiceras arietiforme* Spath. That specimen and also the subsequent material of Spath (1922, p. 137, pl. 2, figs. 6a, 6b) are fragmentary segments of body chambers and the whorl section was drawn by Spath diagrammatically. This species is, thus, based on incomplete material, but it has spiral notches on the long ribs like those of other species of *Elobiceras*.

In spite of this situation, Haas (1942a, p. 647, pl. 93, fig. 19; 1942b, p. 90-95, pls. 18-20) described a number of specimens from the Upper Albian of Angola as *Pervinquieria arietiformis* (Spath), in which several varieties were included in addition to "*forma typica*". He did not state a satisfactory reason why he identified the Angola specimens with the insufficiently defined species of Spath. Also the reason why *Elobiceras arietiforme* should be transferred to *Pervinquieria* of his sense is not clear. Haas (1942b, p. 99; fig. 18 in p. 40) mentioned, however, that there is "a broad transitional zone" from *Pervinquieria* to *Elobiceras* and regarded *Pervinquieria arietiformis* as a species closely approaching *Elobiceras*.

Renz (1971, 1982) transferred the generic name from *Pervinquieria* to *Mortoniceras* (*Mortoniceras*) and reported some examples of *Mortoniceras* (*Mortoniceras*) *arietiforme* from Venezuela, since he compared them with Haas' specimens from Angola.

In our view none of the specimens illustrated under the specific name of *Pervinquieria arietiformis* by Haas or *Mortoniceras* (*Mortoniceras*) *arietiforme* by Renz seems to be identical with the holotype and Spath's specimens of *Elobiceras arietiforme* Spath.

On the other hand, as we have described above (see *Comparison*), the illustrated specimen of Renz' "*Mortoniceras*

Table 1. Measurements of *Mortoniceras* (*Mortoniceras*) cf. *geometricum* and relevant specimens.

Specimen	D	U	U/D	H	H/D	B	B/D	B/H	H/h	Ribs
WE. A211Y (at M)	188	92	0.40	53	0.28	—	—	—	1.23	43
WE. A211Y (at m)	136	65	0.48	42	0.31	—	—	—	1.45	39
Spath (1933, pl. 44, fig. 1)	230	106	0.46	73	0.32	—	—	—	1.43	40
Haas (1942b, pl. 18, fig. 4)	135	51	0.38	45	0.33	30	0.22	0.67	1.15	44
Renz (1971, pl. 4, fig. 1)	185	78	0.42	62	0.34	43	0.23	0.69	1.3	40
Spath (1922, pl. 2, fig. 6)	—	—	—	72	—	44	—	0.61	—	—

The deformed specimen of WE. A211Y is measured as it is; at M along the elongated axis and at m along the shortened axis of the elliptically deformed specimen. Spath (1933, pl. 44, fig. 1): holotype of *Mortoniceras* (*Mortoniceras*) *geometricum*; Haas (1942b, pl. 18, fig. 4): "*Pervinquieria arietiformis*"; Renz (1971, pl. 4, fig. 1); "*Mortoniceras* (*Mortoniceras*) *arietiforme*"; Spath (1922, pl. 2, fig. 6): *Elobiceras arietiforme*. D=diameter, U=width of umbilicus, H=whorl height, B=whorl breadth, h=whorl height half adapical from H, c=costal, ic=interocstal; Ribs=number of ribs to a whorl. Linear dimensions in mm.

Figure 4. *Mortoniceras* (*Mortoniceras*) *rostratum* (J. Sowerby). Lateral view of GK. H8491 from Member Mb at loc. 544, ×1 (photo by N. Egashira without whitening). M : middle part of the adult body chamber ; L : late part of the phragmocone ; arrow : beginning of the body chamber.

(*Mortoniceras*) *arietiforme*" and also some of Haas' "*Pervinquieria arietiformis*" morphologically resemble the Hokkaido specimen in many respects. These specimens, as well as our specimen, are quite similar to *Mortoniceras* (*Mortoniceras*) *geometricum* Spath. Hence, at least provisionally we should call our specimen *Mortoniceras* (*Mortoniceras*) cf. *geometricum* Spath.

Spath (1932, p. 395) regarded *Mortoniceras* (*Mortoniceras*) *geometricum* as distinct from but more allied to *Mortoniceras* (*Mortoniceras*) *pricei* (Spath, 1922) than to *Mortoniceras* (*Mortoniceras*) *inflatum*. This is favorable for the systematic allocation of *Mortoniceras* (*Mortoniceras*) *geometricum*. In fact Kennedy and Hancock (1978, p. v-9) ranked this species as *Mortoniceras* (*Mortoniceras*) *pricei geometricum*, as a member of the *Hysteroceras varicosum* Subzone, although they did not give reasons for the subspecific treatment. So far as the typical forms are concerned, ribs are somewhat flexuous and their alternating long and short feature persists to a later growth stage in *Mortoniceras* (*Mortoniceras*) *pricei*, whereas ribs are nearly rectiradiate, becoming single and more widely spaced at an earlier growth stage in *Mortoniceras* (*Mortoniceras*) *geometricum*.

To sum up, the Hokkaido specimen described above should be called *Mortoniceras* (*Mortoniceras*) cf. *geometricum*. This is provisional but taxonomically best.

Mortoniceras (*Mortoniceras*) *rostratum* (Sowerby, 1817)

Figures 4-7

Ammonites rostratus J. Sowerby, 1817, p. 163, pl. 173.
Mortoniceras (*Pervinquieria*) *rostratum* (Sowerby). Spath, 1932, p. 400, text-fig. 136.
Pervinquieria (*Subschloenbachia*) *rostrata* (Sowerby). Scholz, 1979a, p. 111, pl. 26, figs. 1, 2, pl. 27, figs. 1, 2; Scholz, 1979b, p. 600, pl. 2, figs. 1, 2, pl. 4, fig. 5, pl. 5, fig. 1, text-figs. 2, 3.

Material.—GK.H8491, obtained by Y.K. on 17 August 1994 at loc. Y544 [=Y270139], and GS.G160, also by Y.K. on 26 May 1996 at loc. Y546R1 [=Y272041]; both from Member Mb of the Tengu-zawa route, Yubari Mountains.

Description.—The two specimens are spectacular in showing the adult shell up to the peristome with a recurved rostrum. They are, however, incompletely preserved; namely the first specimen (Figure 4) shows only the right side, with its left side dissolved in the rock matrix to the mid-venter (=half-ammonite preservation: Maeda, 1987). The second specimen (Figures 6, 7) is much distorted, although its venter is partly exposed. Even in side view the younger part less than 40 mm or 30 mm in diameter is not well exposed in both specimens. In spits of these drawbacks, the two specimens exhibit some characteristic features of the species as described below.

The shell is fairly large, about 160 mm in diameter at the point slightly back from the rostrate peristome in the less deformed specimen (Figure 4). This is nearly similar to the restored outline of the holotype (Spath, 1932, text-fig. 136). The distorted specimen (Figures 6, 7) may have been originally somewhat larger than the less deformed one. In both specimens the shell is rather evolute, with a little overlapping of whorls.

The whorl expands with rather moderate to slightly high ratios. The width of the umbilicus is generally moderate, showing U/D 0.36-0.38. Near the last stage immediately behind the rostrate marginal part the increase of whorl-height is lowered, resulting in a somewhat broadened umbilicus with an increased ratio of U/D (0.41) (Table 2). A similar tendency is observable in the holotype from England.

As the specimens preserve only one side, the proportion of B/H is hardly estimated with precision. The values shown in Table 2 may be affected to some extent by secondary compression. The change of B/H with growth is not correctly known in our material. It is, however, noted that the

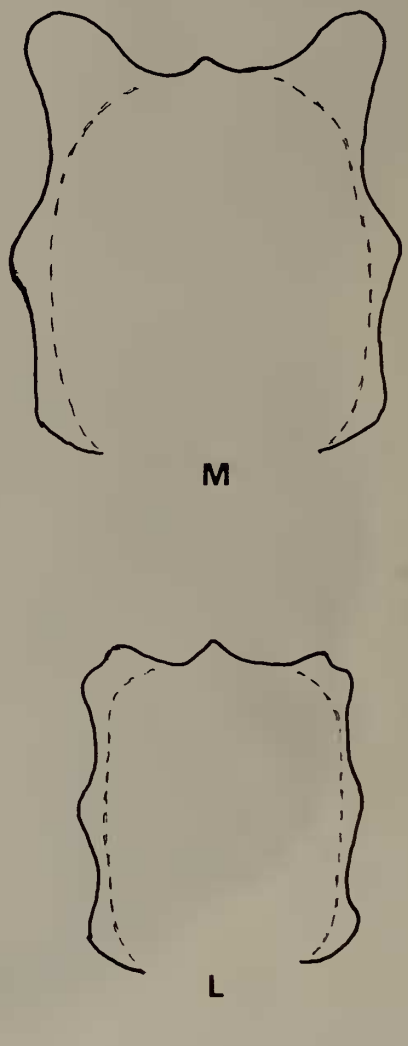

Figure 5. *Mortoniceras* (*Mortoniceras*) *rostratum* (J. Sowerby). Restored whorl sections. M: at the middle of the adult body chamber; L: late part of the phragmocone (drawn by T.M. based on the two specimens from Member Mb of the Tengu-zawa route). Bar scale: 10 mm.

inner whorls are rather flat-sided and that the adult body chamber is thickly oval or subelliptical in the intercostal section (Figure 5).

The main part of the body chamber occupies half a whorl (Figure 4). In addition to it there is a marginal part which shows a broadly convex curve along the peristome and extends to a recurved rostrum. Although the apical part of the rostrum was broken away in our specimens, the observable part is similar to that of the holotype (Sowerby, 1817, pl. 173).

The ornament is very characteristic. In the main part of the body chamber there are seven robust ribs which are distantly separated. They are weakly prorsiradiate or very gently concave forward, with or without a slight bending at about the mid-flank. Each rib has a bullate umbilical tubercle, a lateral node, which may have a bullate extension along the rib, and a ventrolateral horn developed from the united inner and outer ventrolateral tubercle of the preceding stage (Figure 5). The median ventral keel is lower than the top of the ventrolateral horns of the most robust ribs in the middle part of the body chamber (Figure 5). There is an additional rib in the basal part of the rostrum. It is narrower and lower than the ribs of the main part and extends to the axial part of the recurved rostrum (Figures 4, 7). Its mid-lateral and ventrolateral tubercles are narrowly bullate, showing a rather sharp summit. In addition to it there are two still narrower and lower riblets on the marginal part.

In the last part of the phragmocone, for about one third of the whorl, the ribs are mostly single, rectiradiate and coarse (Figure 4). Their interspace is somewhat broader than the rib in the late part of the segment and nearly as broad as the rib in the early part. Each rib has a bullate umbilical tubercle, a mid-lateral node and a doubled ventrolateral tubercle, althought the ventrolateral part of some ribs is incompletely preserved at this substage. There is an exceptionally short rib at the end of the phragmocone (Figure 4).

The ribs in the earlier part of the septate whorls are denser and narrower than those in the later part. They consist of longer ones and bifurcated or intercalated shorter ones. The umbilical and lateral tubercles are observable; the ventrolateral part is concealed by the overlapping outer whorl.

The external suture is partly exposed on GK.H8491. It shows comparatively broad stems of E/L, L and L/U2 and their minor incisions.

Dimensions.—See Table 2.

Comparison.—The two specimens described above are comparable with the holotype of *Mortoniceras* (*Mortoniceras*) *rostratum* (J. Sowerby) (see Spath, 1932, text-fig. 136), from the Upper Albian Malmstone of Oxfordshire (England), and the four adult specimens of the same species illustrated by Scholz (1979a, pl. 26, fig. 1 and pl. 27, fig. 2; 1979b, text-figs. 2, 3), from the "Vraconian" of the Bakony Mountains (West Hungary), the "Upper Vraconian" of France and the "Vraconian" of Germany. As the available specimens are not numerous, we have to compare particular individuals. For example, the ribs on the main part of the adult body chamber are more robust and separated by wider interspaces in the Hokkaido specimens than those of the holotype, but they are nearly similar to those of the French specimen. The lateral tubercles are disposed at about the middle of the flank in our specimens, but they are shifted outward in the five specimens from Europe. This may be merely an intraspecific variation. Even if this difference occurred in many individuals between the two separate provinces, it could be interpreted as suggesting a geographic subspecies.

With respect to the characteristic ornament of the adult body chamber our material appears to resemble *Mortoniceras* (*Mortoniceras*) *stoliczkai* (Spath, 1921). The latter is represented by "*Ammonites inflatus* var. I" of Stoliczka (1863, p. 49, pl. 27, fig. 1; pl. 29, fig. 2), from the Utatur Group of southern India, and also by "*Subschloenbachia stoliczkai*" of Spath (1922, p. 119, text-figs. c1, c2), from the Albian of Angola. Spath (1932, p. 404) discussed at length the distinction between *Mortoniceras* (*Mortoniceras*) *stoliczkai* and *Mortoniceras* (*Mortoniceras*) *rostratum*, but such characters as bending of ribs and stage of appearance of simple ribbing are not tenable because of variability. The only criterion is the more depressed whorl of the former than of the latter. In this respect our specimens are not referable to *Mortoniceras* (*Mortoniceras*) *stoliczkai*.

Occurrence.—As for material.

Discussion.—Scholz (1979a, b) has upheld the quadrituberculate ornament as the most reliable criterion by which to distinguish *Ammonites rostratus* from the trituberculate *Mortoniceras* (*Mortoniceras*) *stoliczkai*. A well-preserved specimen from the Upper Albian of Madagascar illustrated by Collignon (1963, p. 156, pl. 304, fig. 1308) as *Mortoniceras rostratum* has been revised by Scholz to *Mortoniceras* (*Mor-*

Table 2. Measuremens of *Mortoniceras* (*Mortoniceras*) *rostratum*.

Specimen	D	U	U/D	H	H/D	B	B/D	B/H	H/h	Ribs
Holotype (E-60°, ic)	160	61	0.38	55	0.34	~40	0.25	0.73	1.25	13+10
Holotype (E-90°, ic)	140	50	0.36	52	0.37	~39	0.28	0.75	1.37	11+14
GK. H8491 (E-45°, ic)	147	61	0.41	50	0.34	~36	0.24	0.72	1.39	13+11
GK. H8491 (E-60°, c)	157	60	0.38	56	0.37	~ 8	0.31	0.86	1.37	13+13
GS. G160 (E-45°, ic)	165	63	0.38	56	0.34	~42	0.25	0.75	1.22	14+11
GS. G160 (E-90°, c)	156	59	0.38	55	0.35	~50	0.32	0.91	1.31	13+14

As specimens are all secondarily compressed and distorted, B is estimated from the measured dimension of a less deformed half side. Ribs: number of ribs to a whorl (later single ribs+earlier bifurcating or intercalating ribs). Holotype is measured on a cast. E: preserved end of the whorl, E-60°: at the point 60° adapically from E, ~: approximate. Other abbreviations same as in Table 1.

toniceras) *stoliczkai* [=*Pervinquieria* (*Pervinquieria*) *stoliczkai* of Scholz, 1979a, p. 106]. Collignon (1963), however, made mention of the variability of ornament in the Madagascar material. Without examining the actual specimens, we hesitate to comment further. In connection with this question, it is noted that one of the specimens from the Utatur Group described under the name of "*Ammonites inflatus* var. III" by Stoliczka (1863, pl. 29, figs. 4, 4a) shows a double ventrolateral tubercle in his schematic whorl section.

Subgeneric assignment of *Mortoniceras rostratum* is indeed debatable. Spath (1932, p. 400) described this species under *Mortoniceras* (*Pervinquieria*), that is *Mortoniceras* (*Mortoniceras*) of the present nomenclature. Scholz (1979a, b) evaluated *Subschloenbachia* Spath, 1921 [with type species *Ammonites rostratus* J. Sowerby, 1817] as a senior synonym of *Durnovarites* Spath, 1932 [with type species *Subschloenbachia perinflata* Spath, 1921]. Cooper and Kennedy (1979, p. 269) listed a number of species which they refer to the subgenus *Durnovarites* and added *Mortoniceras* (*Durnovarites*) *collignoni* Cooper and Kennedy, 1979 (p. 276, figs. 65E-F, 66-67, 68B-D, 69) from Angola. For some reason they did not include *Ammonites rostratus* in the list of *Mortoniceras* (*Durnovarites*), but Cooper and Kennedy (1979, p. 280) mentioned that "the ribs of the body chamber of *Mortoniceras rostratum* retain four rows of tubercles almost to the peristome". This is probably a misobservation stemming from the unfavorable preservation. At present Kennedy (in reply to T.M.'s inquiry, 24 April, 1997) believes *Subschloenbachia* and *Durnovarites* to be synonyms and is going to describe, together with co-authors, *Mortoniceras* (*Subschloenbachia*) *rostratum* from the Weno Formation (Albian) in northeast Texas.

Thanks to W.J. Kennedy, we are now looking at the cast of the holotype of *Ammonites rostratus*. Up to 90 mm or so in diameter (with H=43 mm), the ribs are fairly crowded and the inner and outer ventrolateral tubercles are not well differentiated and covered with spiral striations. This feature is essentially similar to that of middle-aged *Mortoniceras* (*Mortoniceras*) *inflatum* (Sowerby), as illustrated by Spath (1931, pl. 35, fig. 9; 1932, text-fig. 127). For about a quarter whorl in the last part of the phragmocone the ribs are thicker and become gradually distant, the inner and outer ventrolateral tubercles are somewhat separated, and thus a quadrituberculate state is manifested. However, the inner node and the outer clavus are never widely separated and seem to rest on a common base of the thickened outer end of a rib. In a little while the two ventrolateral tubercles are closely set and become a double ventrolateral tubercle. Then on the body chamber the paired tubercle is completely united to become a single prominent tubercle. Thus the body chamber is apparently trituberculate (Figure 5). These are essentially similar to the features in the holotype of *Mortoniceras* (*Mortoniceras*) *vespertinum* (see Wright, 1996, figs. 109a, b), although the ventrolateral nodes are not horn-like in that holotype.

On the other hand, *Mortoniceras* (*Durnovarites*) *perinflatum*

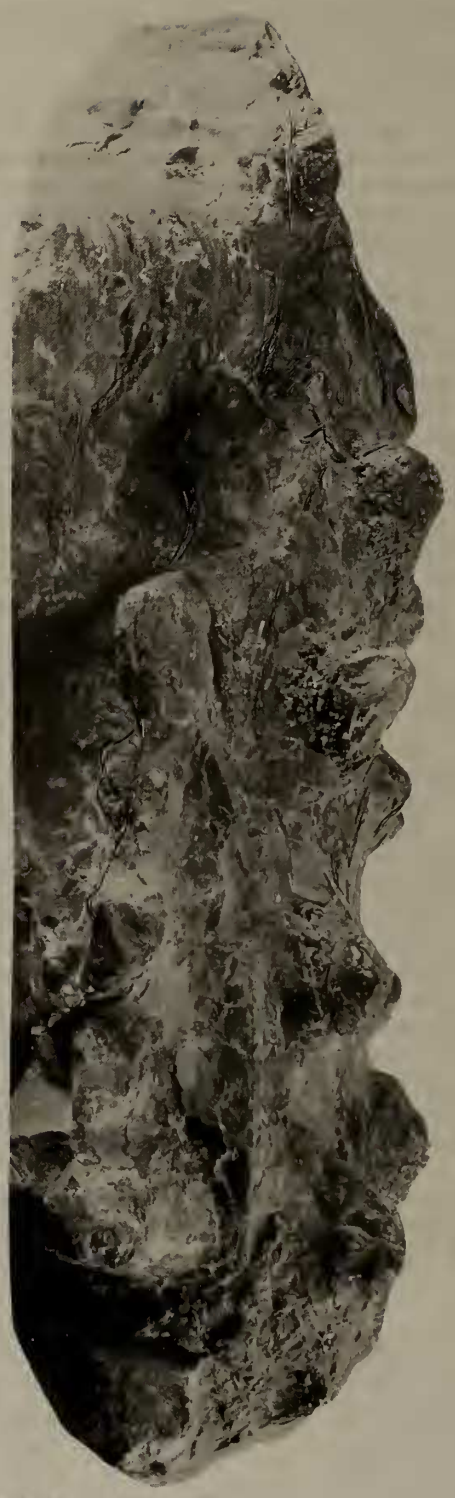

Figure 6. *Mortoniceras* (*Mortoniceras*) *rostratum* (J. Sowerby). Ventral view of GS. G160 from Member Mb at loc. Y546R1, ×1 (photo by N. Egashira without whitening).

Figure 7. *Mortoniceras* (*Mortoniceras*) *rostratum* (J. Sowerby). Lateral view of GS. G160 from Member Mb at loc. Y546R1, ×1 (photo by N. Egashira, without whitening).

is regarded as quadrituberculate even on the body chamber. In fact, *Mortoniceras* (*Durnovarites*) *collignoni* has four rows of tubercles on one side of the body chamber, without forming ventrolateral horns. In *Mortoniceras* (*Durnovarites*) *subquadratum* Spath, 1933 (p. 435 ; 1932, pl. 37, fig. 6 ; pl. 42, figs. 5, 9 ; 1933, pl. 43, fig. 7 ; pl. 44, fig. 6 ; pl. 47, figs. 2-4 ; pl. 48, figs. 2, 4) the quadrituberculate state appears earlier than in other species, although the adult body chamber of this species has not been described.

Strictly speaking, the holotype of *Mortoniceras* (*Durnovarites*) *perinflatum*, as reillustrated by Renz (1968b, pl. 9. figs. 1a, b), is wholly septate, although its quadrituberculate state is well shown in its preserved last part. A specimen figured by Scholz (1979a, pl. 28, figs. 2a, b), which is explained as "typical example with body chamber" dose not seem to preserve completely the adult body chamber. Should this species retain the quadrituberculation up to the last part of the adult body chamber, then *Mortoniceras* (*Durnovarites*) would not necessarily be regarded as subgenerically identical with *Mortoniceras rostratum*, because the latter is trituberculate throughout the whole stage of the adult body chamber.

In connection with the above question, "*Mortoniceras* (*Styphloceras*) *lowrii* McLearn" (1972, p. 72, pl. 30, figs. 1-3 ; pl. 39, fig. 4), from the Haida Formation of British Columbia, shows a similar mode of tuberculation. Thanks to the late J.A. Jeletzky's kindness, a plaster cast of the holotype of this species is in Kyushu University. It resembles *Mortoniceras rostratum* in important points, namely (1) the quadrituberculate ornament appears for a short while on the last quarter of the septate whorl, (2) the two ventrolateral tubercles in the above substage are paired as was written in detail by McLearn, and (3) the paired tubercles are united into a prominent ventrolateral tubercle and the trituberculate state characterized almost the whorl period of the adult body chamber, although the prominent ventrolateral tubercles are mostly broken in that specimen, with only a few remains without damage. The difference of this species from *Mortoniceras rostratum* is the much depressed shape of the phragmocone with a broadly rounded venter and in the details of the ornament in the adult stage.

Our material, including the Hokkaido specimens described above and also a previously reported one from Kyushu (Matsumoto and Tashiro, 1975, p. 232, pl. 25, fig. 1 ; text-fig. 2 under *Mortoniceras* aff. *rostratum*), shows generally the same pattern of ornament as that of the holotypes of *Mortoniceras rostratum* and *Mortoniceras lowrii*. Scholz (1979a, p. 111) mentioned that the quadrituberculate state appears in small immature examples of *Mortoniceras rostratum*. This cannot be examined either in our specimens or in the holotype of *Mortoniceras rostratum* or that of *Mortoniceras lowrii*.

At any rate, the quadrituberculate character which appears in a quite limited substage of ontogeny in the two species (i.e. *Mortoniceras rostratum* and *Mortoniceras lowrii*) can be regarded as incipient, foretelling the more typically quadrituberculate characters of *Mortoniceras* (*Durnovarites*). On the other hand, in having widely separated ribs with ventrolateral horns as well as lateral and umbilical tubercles on the body chamber, *Mortoniceras rostratum* resembles *Mortoniceras* (*Mortoniceras*) *stoliczkai*. In other words, with respect to the ornament *Mortoniceras rostratum* is so to speak intermediate between typical *Mortoniceras* (*Mortoniceras*) and *Mortoniceras* (*Durnovarites*). It might be possible to define the subgenus *Mortoniceras* (*Subschloenbachia*) for such an intermediate subgroup as represented by *Mortoniceras rostratum*. This may be also biostratigraphically convenient. However, our knowledge is still insufficient in various respects and especially in regard to the characters of the full-grown *Mortoniceras perinflatum*. For the time being it is better to follow Wright (1996, p. 141) to use the subgenus *Mortoniceras* (*Mortoniceras*) even for the subgroup of *Mortoniceras rostratum*, although *Mortoniceras* (*Mortoniceras*) may be considered as being defined more comprehensively than other subgenera.

Geological implications

Mortoniceras (*Mortoniceras*) cf. *geometricum* (Spath) and *Mortoniceras* (*Mortoniceras*) *rostratum* (J. Sowerby) described in this paper are the first record of these two species from Hokkaido. This supports the general point that the ammonite species of the Brancoceratidae often show worldwide distribution and that they are useful for interregional correlation irrespective of the provincial difference of the faunas. Furthermore, the described species give a substantial line of evidence for the stratigraphic relationship between the Lower Yezo Subgroup and the Middle Yezo Subgroup in Hokkaido.

Mortoniceras (*Mortoniceras*) *geometricum* is an element of the Assemblage Subzone of *Hysteroceras varicosum* in the middle part of the Upper Albian in England. The species identified with *Mortoniceras* (*Mortoniceras*) *geometricum* in our definition has been reported to occur, together with *Mortoniceras* (*Mortoniceras*) *pricei*, from the correlative of the same subzone in Venezuela (Renz, 1971) and probably in Angola (Haas, 1942b), although it was inadequately called *Mortoniceras* (*Mortoniceras*) *arietiformis*.

Although the subgeneric assignment is debatable, what we provisionally call *Mortoniceras* (*Mortoniceras*) *rostratum* [=*Mortoniceras* (*Subschloenbachia*) *rostratum* by some authors] is a characteristic element of the Assemblage Subzone of *Arrhaphoceras substuderi* in the lower part of the tripartite upper part of the Upper Albian in Europe.

In the Tengu-zawa route *Mortoniceras* (*Mortoniceras*) cf. *geometricum* occurs in Member Ld and *Mortoniceras* (*Mortoniceras*) *rostratum* at the middle horizon of Member Mb. These two stratigraphic levels are quite adequate, provided that the Subzones of the Upper Albian in Europe be correlated with the subdivisions in Japan. It can be also stated that the boundary of the Lower Yezo Subgroup and the Middle Yezo Subgroup is located within the Upper Albian and that the boundary plane dose not represent a significant time gap.

It should be noted that Nishida *et al.* (1996, 1997) came recently to a similar conclusion concerning the stratigraphic relationship between the Lower Yezo and Middle Yezo Subgroups in the Soeushinai area of the Teshio Mountains, northwestern Hokkaido. In that area, however, the level of the boundary is between the *Hysteroceras orbinyi* Subzone

and the *Hysteroceras varicosum* Subzone.

Acknowledgements

We thank C.W. Wright (Beaminster) for a helpful reply to the inquiry from one of us (T.M.), W.J. Kennedy (Oxford) for a gift of a cast together with his opinion and a part of the unpublished manuscript, Hiromichi Hirano (Waseda University) and Tamio Nishida (Saga University) for valuable discussions, and further Seiichi Toshimitsu (GSJ, Tsukuba) and Naoko Egashira (Saga) for kind help in technical aspects.

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Fukuoka 福岡, Hokkaido 北海道, Kyushu 九州, Mikasa 三笠, Oyubari 大夕張, Saga 佐賀, Shuparo シューパロ, Shuyubari [Siyubari] 主夕張, Soeushinai 添牛内, Tengu-zawa 天狗沢, Teshio Mountains 天塩山地, Tokyo 東京, Tomatsu Chiyoda 唐松千代田, Tsukuba つくば, Yubari Mountains 夕張山地
